Mathematics Toolkit: Grade 4 Objective 2.B.2.a

Standard 2.0 Knowledge of Geometry

Topic B. Solid Geometric Figures

Indicator 2. Analyze the relationship between plane geometric figures and surfaces of solid geometric figures

Objective a. Compare a plane figure to surfaces of solid geometric figure

Assessment Limits:

Analyze or identify the number or arrangement of squares needed to make a cube and triangles/rectangles needed to make a triangular pyramid or rectangular pyramid.

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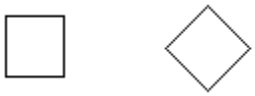
Clarification

Mathematics Grade 4 Objective 2.B.2.a Assessment Limit 1

The van Hiele Levels of Geometric Thought
Pierre and Dina van Hiele are two Dutch educators who developed a model for developing geometric reasoning. Their model is based on a five-level hierarchy that *all* students move through as they develop their geometric understandings.

Level 0: Visualization Students are able to recognize and name figures. They are able to group shapes that seem to be alike. They can recognize a square because it looks like a square. But if the square were rotated 45°, students might not recognize it as a square.



Level 1: Analysis At this level, students begin to focus more on the properties of a shape rather than its size or orientation. Students are able to think of shapes within a class and know that all shapes in that class have certain properties. Students will recognize that all cubes have faces that are squares. At this level, however, students may not recognize that all cubes are a subclass of rectangular prisms.

Level 2: Informal Deduction Students at this level begin to use logical reasoning by developing relationships between the properties of a class of shapes. For example: If a figure is a square it has four congruent sides. If it has four congruent sides then the figure is a rhombus. If a figure is a square it is a rhombus.

Level 3: Deduction At this level, students are able to evaluate more than just the properties of shapes. They begin to examine geometry as a system with definitions, axioms and theorems. Students at this level work with abstract statements and make conclusions based on logical deduction. This is the level of the traditional high school geometry course.

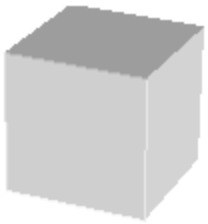
Level 4: Rigor This is the highest level of geometric reasoning. At this level, students compare relationships of figures within different systems of geometry.

Students that are asked to analyze the types, numbers and arrangement of shapes that are the faces of a solid figure are moving from Level 0 to Level 1.

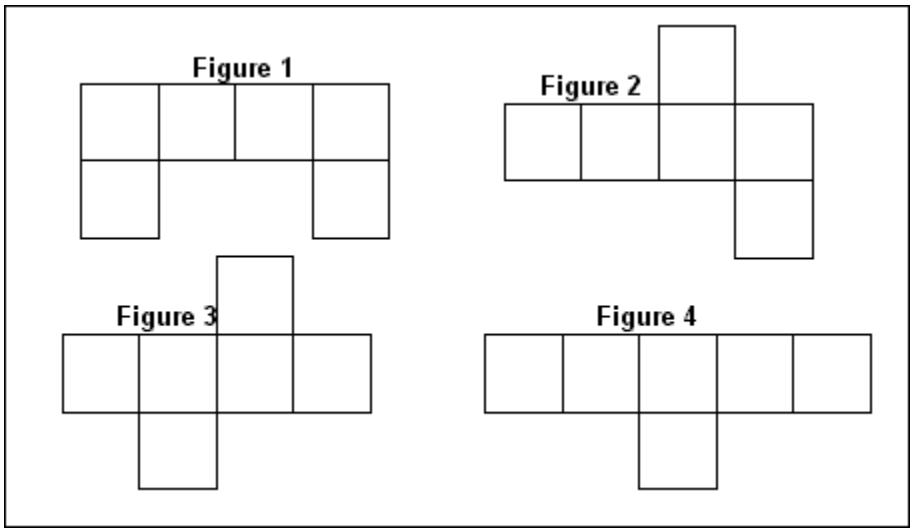
- They can identify that the faces of a cube are squares (Level 0).
- But to form a cube, the squares cannot be in any random arrangement. (Level 1).

Classroom Example 1

Look at the cube below:



- How many squares make up the cube?
- Which figures below, when cut out, will form a cube?



Lesson Seeds

Mathematics Grade 4 Objective 2.B.2.a Assessment Limit 1

Materials needed

- Plastic drinking straws with flexible joints
- Toothpicks or pretzel sticks and gumdrops or marshmallows
- Paper nets of solid figures
- Solid figure models

Activities

"Building a model of a three-dimensional shape is an informal way to get to understand the shape intuitively in terms of its component parts."[1]

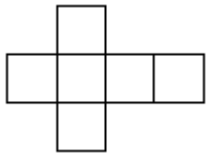
When students build 3-dimensional models they are actively engaged in examining the parts, the number of parts and the arrangement of parts of each figure. These constructed 3-dimensional models (or solid figure models) can then be used to compare and contrast the various solid figures in terms of vertices, edges, faces and bases.

- Students can build skeletal models of three-dimensional shapes using rods of some sort. Suggested materials to use:
  - Plastic drinking straws with bendable joints
  - Toothpicks or pretzel sticks to represent the edges. Use gumdrops or miniature marshmallows to represent the vertices.

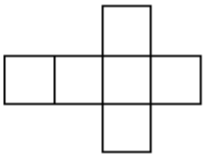
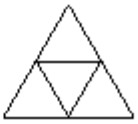
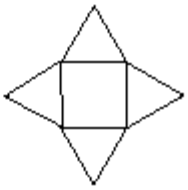
- Give the students small paper squares and tape. Working in pairs or small groups, the students should find as many different arrangements (nets) as possible for six squares. As they complete a net, they will tape the squares together and determine whether the net, when folded, forms a cube.

  Note: A net is an arrangement of polygons that can be folded into a geometric solid.

  Example:

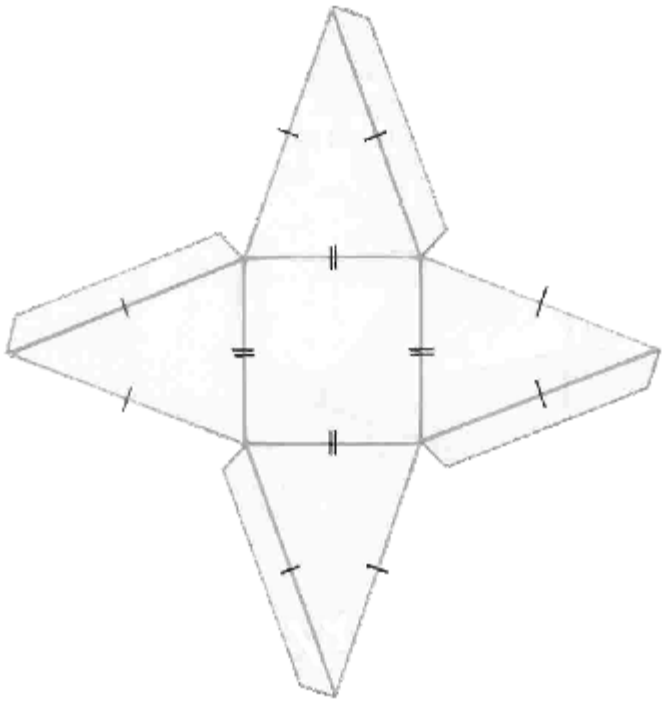


- Make a copy of each of the following nets for the students. Working in pairs or small groups, have student construct the different geometric solids. As students are working, discuss the shape of the faces. When the solids are constructed, have students discuss the number of faces, edges, and vertices.

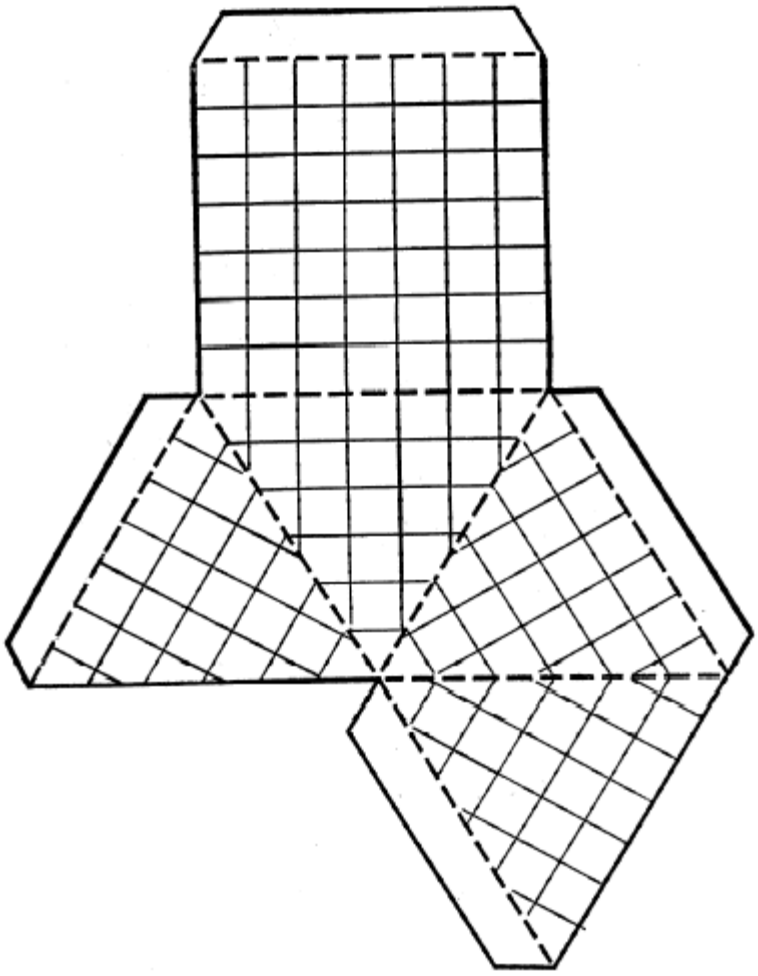
Solid	Nets Note: There are other possible arrangements/nets that can be used to form these solids.
Cube 	
Triangular pyramid 	
Rectangular pyramid 	

- Give students triangular and rectangular pyramids, triangular and rectangular prisms – if possible use several examples of different sizes. Have them work in groups to find similarities and differences of the two pyramids. Have students form a definition of each pyramid. Compare the definitions from each group to generate a class definition.

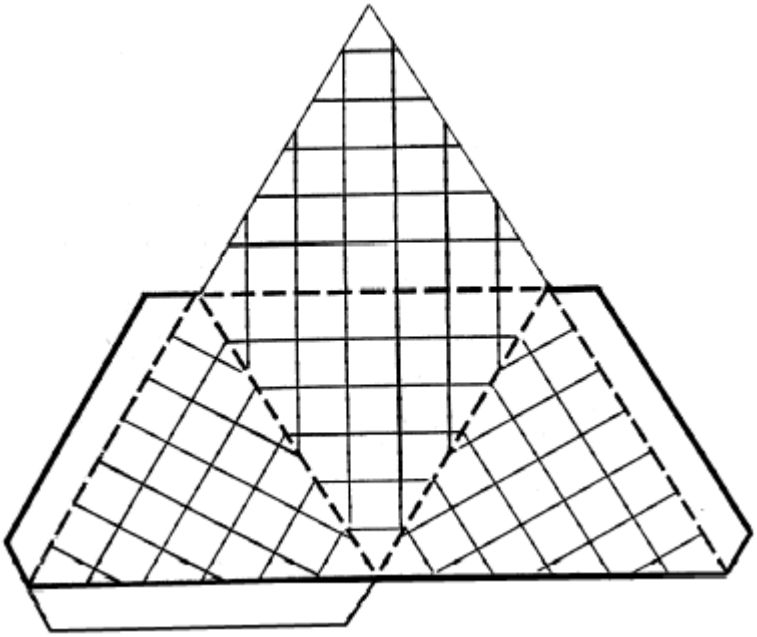
  Rectangular Pyramid Model 1



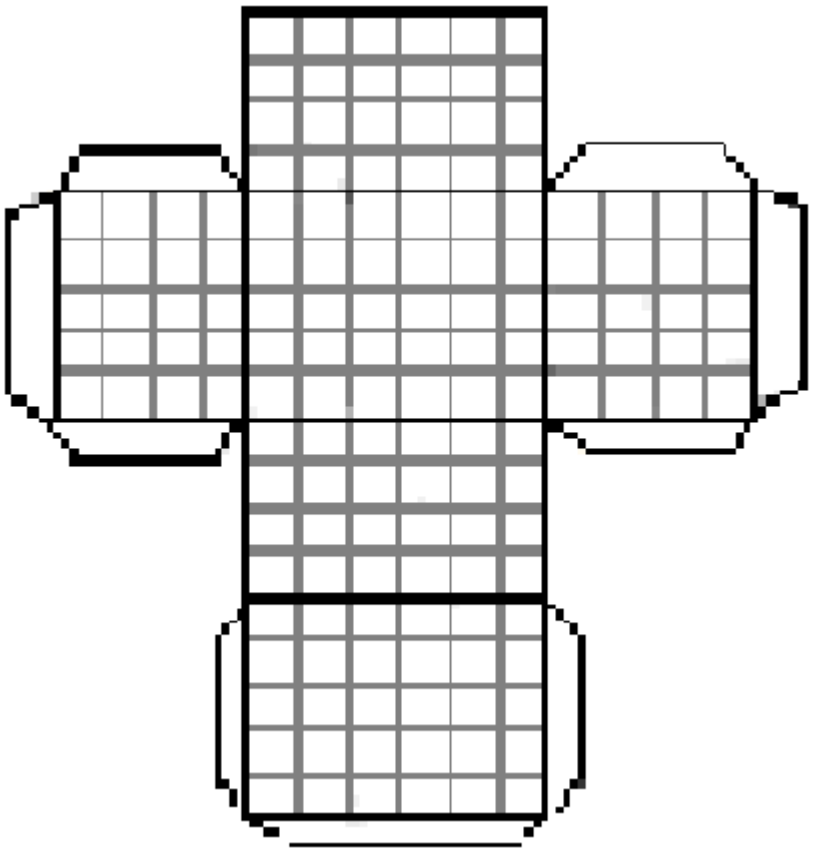
Rectangular Pyramid Model 2



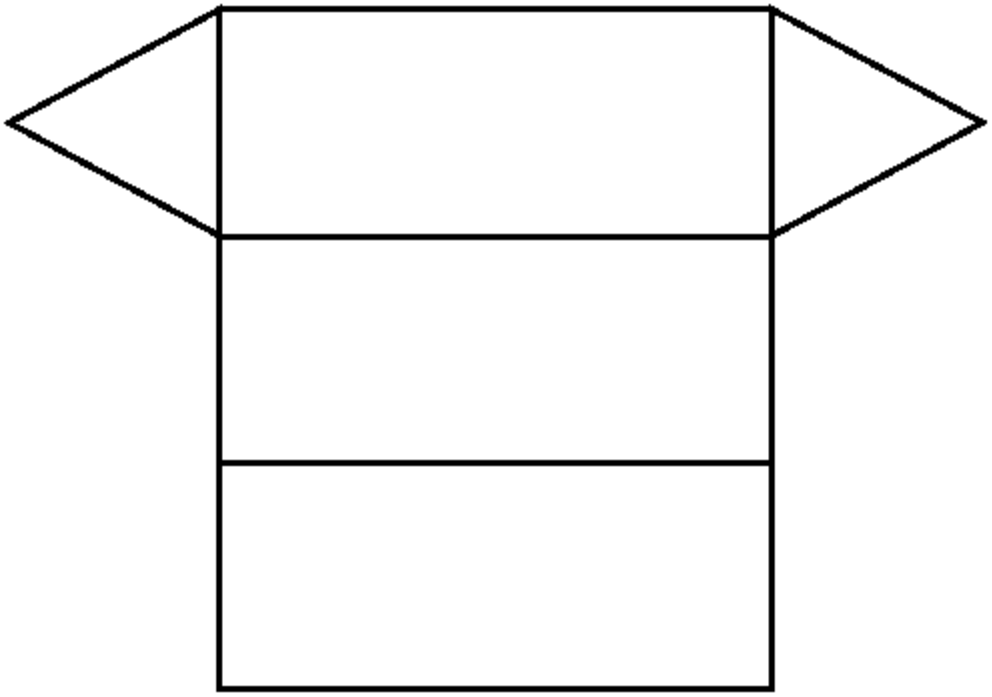
Triangular Pyramid Model



Rectangular Prism Model



Triangular Prism Model



[1]Van de Walle, John, *Elementary and Middle School Mathematics, Teaching Developmentally, 4th Edition*, Longman, 2001.